Aortic Valve Repair:
A Modular (Standardized) Approach

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Tite

Repair-oriented classification of aortic insufficiency: Impact on surgical techniques and clinical outcomes

Munir Boodhwani, MD, MMSc, Laurent de Kerchove, MD, David Glineur, MD, Alain Poncelet, MD, Jean Rubay, MD,
Parla Astarci, MD, Robert Verl

Objective: Valve repa
aortic disease. Over tl
strategy and can predi
valve repair.

Methods: From 1996
age – 54 ± 16 years;
hundred fifty three pa
had type III (restrictiv

Results: In-hospital m
pair. Functional classi
techniques being
47 [29–73] mont
95 ± 3%. Ten p
and from AV rec
9%; 93 ± 5%) or

Conclusion: Aor
functional classif
niques required a
tion, is an import

Limitations:

- Purely echocardiographic, does not directly relate to morphology/pathology
- Does not provide morphologic cut-offs for decision making
- Insensitive in defining cusp prolapse in presence of marked aortic dilatation
- Type III does not differentiate between restricion due to aortic dilatation and restriction due to cusp degeneration/retraction

F
F

IHG

Aortic Valve Repair Using a Differentiated Surgical Strategy

Frank Langer, MD; Diana Aicher, MD; Anke Kissinger, Olaf Wendler, MD; Henning Lausberg, MD; Roland Fries, MD; Hans-Joachim Schäfers, MD

Background—Reconstruction of the aortic valve for aortic regurgitation (AR) remains challenging, in part because of not only cusp or root pathology but also a combination of both can be responsible for this valve dysfunction. We have systematically tailored the repair to the individual pathology of cusps and root.

Methods—Between October 1995 and August 2003, aortic valve repair was performed in 282 of 493 patients undergoing surgery for AR and concomitant disease. Root dilatation was corrected by subcommissural plication (n=59), supracommissural aortic replacement (n=27), root remodeling (n=175), or valve reimplantation within a graft (n=24). Cusp prolapse was corrected by plication of the free margin (n=157) or triangular resection (n =36), cusp defects were closed with a pericardial patch (n=16). Additional procedures were arch replacement (n=114), coronary artery bypass graft (n=60) or mitral repair (n=24). All patients were followed-up (follow-up 99.6% complete), and cumulative follow-up was 8425 patient-months (mean, 33±27 months).

Results—Eleven patients died in hospital (3.9%). Nine patients underwent reoperation for recurrent AR (3.3%). Actuarial freedom from AR grade ≥II at 5 years was 81% for isolated valve repair, 84% for isolated root replacement, and 94% for combination of both; actuarial freedom from reoperation at 5 years was 93%, 95%, and 98%, respectively. No thromboembolic events occurred, and there was 1 episode of endocarditis 4.5 years postoperatively.

Conclusions—Aortic valve repair is feasible even for complex mechanisms of AR with a systematic and individually tailored approach. Operative mortality is low and mid-term durability is encouraging. The incidence of valve-related morbidity is low compared with valve replacement. (*Circulation*. 2004;110[suppl II]:II-67–II-73.)

A
A
C
M
R
Ir
Calcific degeneration

Cusp pathology

THG

ELSEVIER

European Journal of Cardio-thoracic Surgery 28 (2005) 850–856

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Aortic root dilatation may alter the dimensions of the valve leaflets☆

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Geoffrey G. Gong[a], Brett L. Fowler[a]

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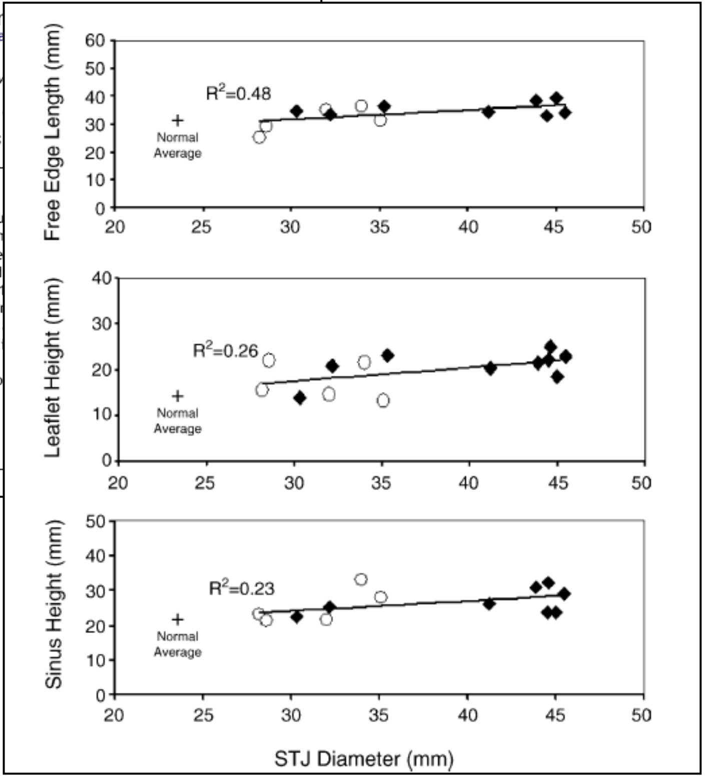
Received 22 June 2005; received in revised form 20 August 2005; accepted 18 September 2005;

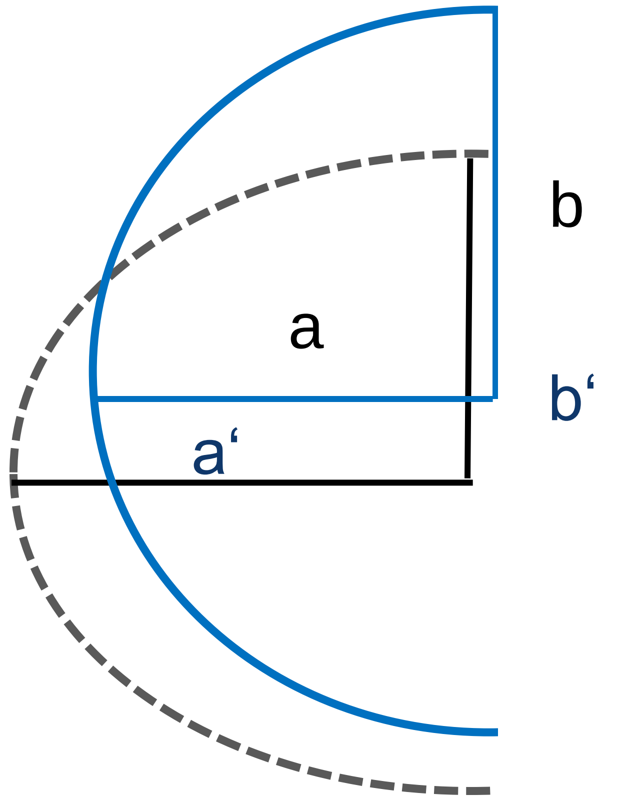
Abstract

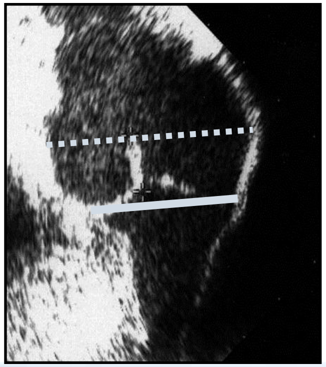
Objective: Valve-sparing surgery can be used in patients with dilated aortic roots and aortic insu
practice, in part because the spared valve may be incompetent. Our goal was to study how the di
changed in such patients. **Methods:** Fourteen patients with dilated aortic root and AI were examine
annulus diameter, sinotubular junction (STJ) diameter, sinus height, leaflet free-edge length, and
among these dimensions and with the AI grades were explored. Measurements were also made in
molds. **Results:** There was no evident change in the average diameter of the annulus between the
roots. The STJ diameter was obviously increased in the dilated aortic roots; the aortic sinuses also
than normal. The leaflet free-edge length, the leaflet height, and the sinus height were found to
degree of AI was not found to correlate well with any of the dimensions measured. **Conclusions:**
parallel to aortic root dilatation with AI. Therefore, during valve sparing, it may be necessary to co
leaflet free-edge length to achieve a competent valve.

Keywords: Aortic valve; Aortic root; Leaflets; Dimensions; Aneurysm; Insufficiency



Reduction of STJ and Cusp Prolapse





$$C_E = \pi \times \; [3/2 \times (a+b) - \sqrt{a \times b}]$$

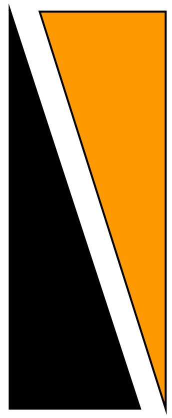
$$b \approx r_{aorta}$$
$$a \approx r_{cusp} \quad \Longrightarrow \quad r_{cusp} \approx 1 / r_{aorta}$$

Standardized Aortic Valve Repair

Assessment

Correction

Root pathology



Valve morphology
Cusp pathology

Root Assessment

Echo:

Maximum sinus diameter ► >40 / 45 mm?

ST diameter ► >35 (?)

Annular diameter (?)

Intraoperative:

Annular diameter (!) ► >25 / 28 mm?

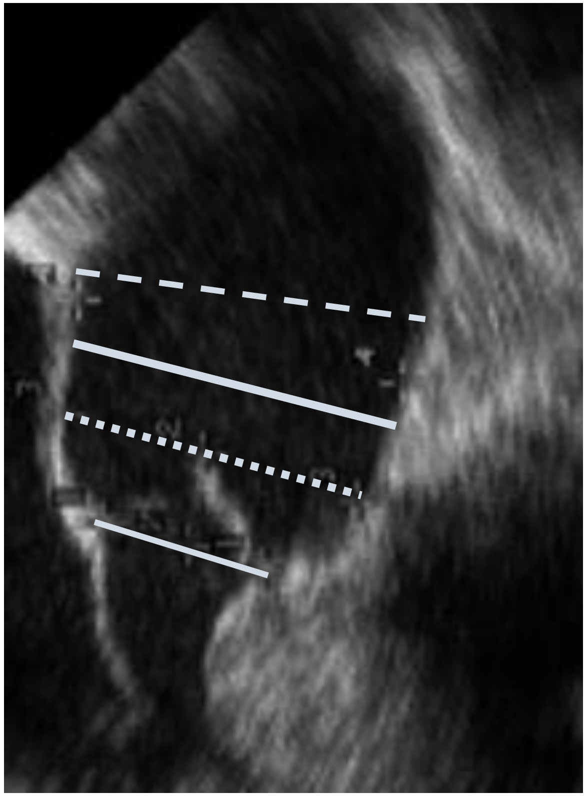
AI und TTE/TEE

Root dimensions

AV morphology (bi-/tricuspid)

Prolapse

Calcification?



Cusp Assessment

Echo:

- Valve morphology?
- Eccentricity of jet?

Intraoperative:

- Valve Morphology?
- Cusp height/configuration?
- Cusp substance?

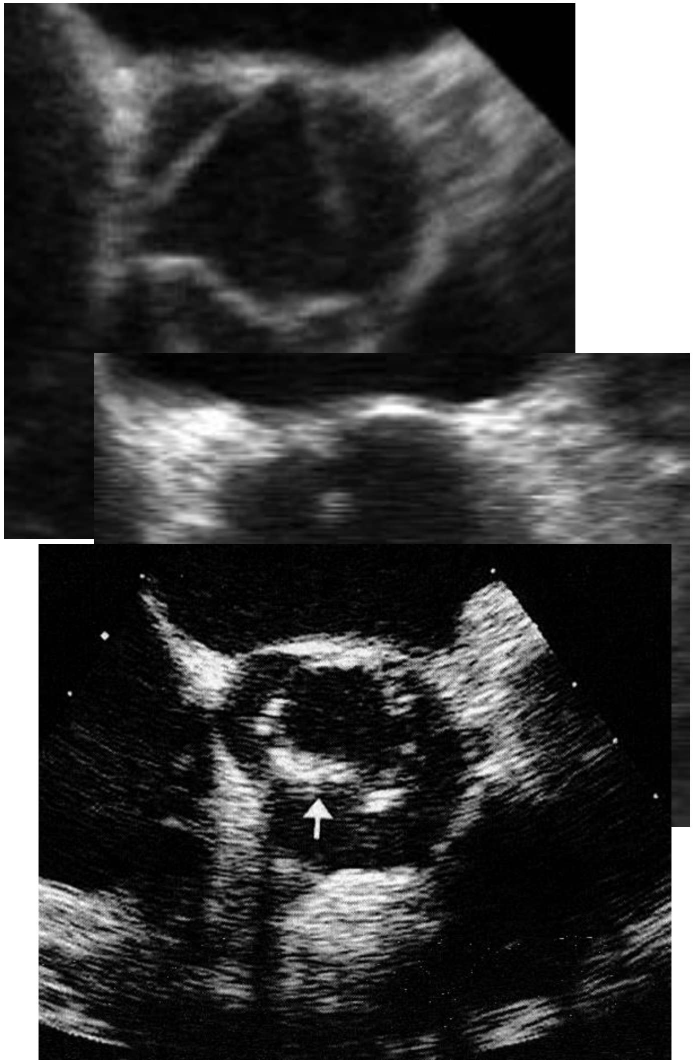
AI und TTE/TEE

Root dimensions

AV morphology (bi-/tricuspid)

Prolapse

Calcification?



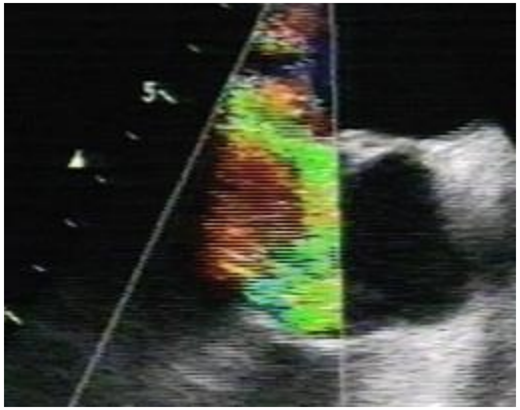
AI und TTE/TEE

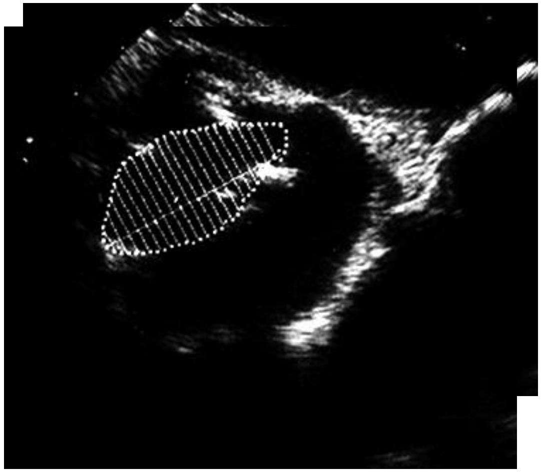
Root dimensions

AV morphology (bi-/tricuspid)

Prolapse

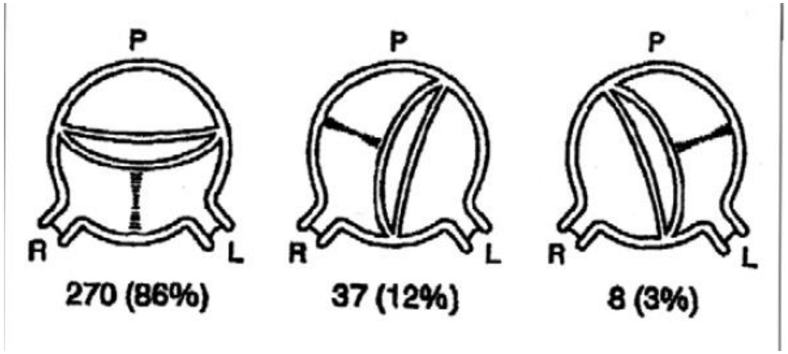
Calcification?



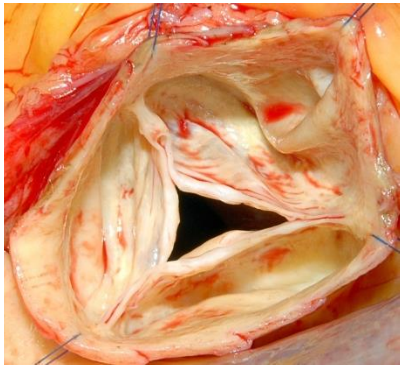


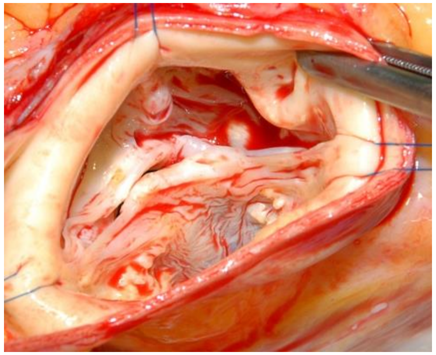
Bicuspid Aortic Valve (BAV) Morphology

pattern of fusion



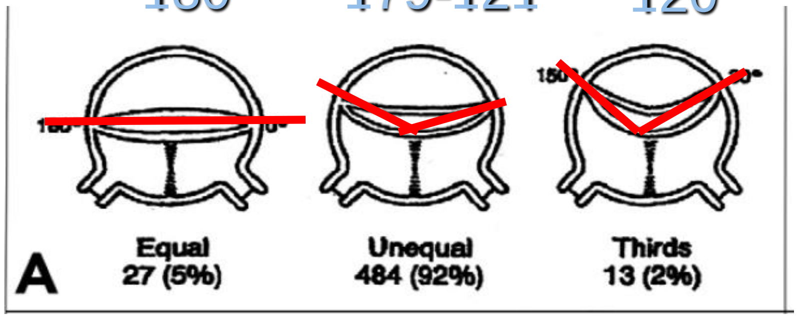
degree of fusion





commissural orientation

180°
179-121°
120°



Sabet et al, *Mayo Clin Proc*, 1999;74:14-26

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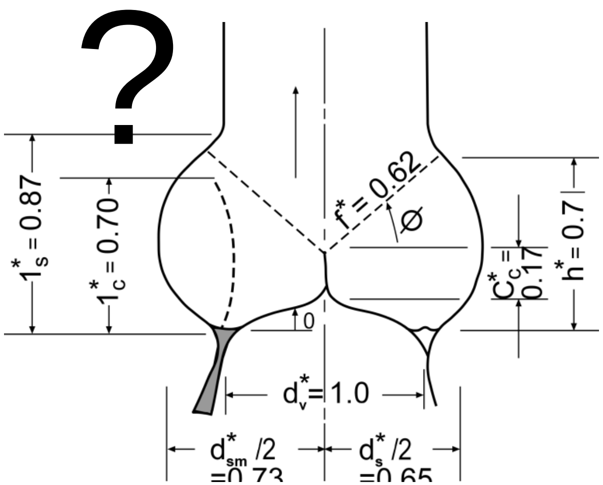
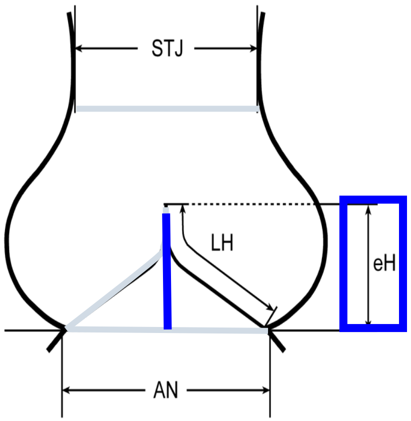
Aortic Valve Repair - Assessment

Configuration of cusps



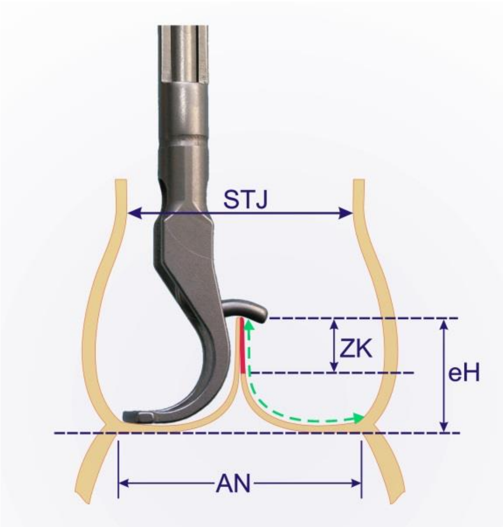
Swanson, Circ Res 1974

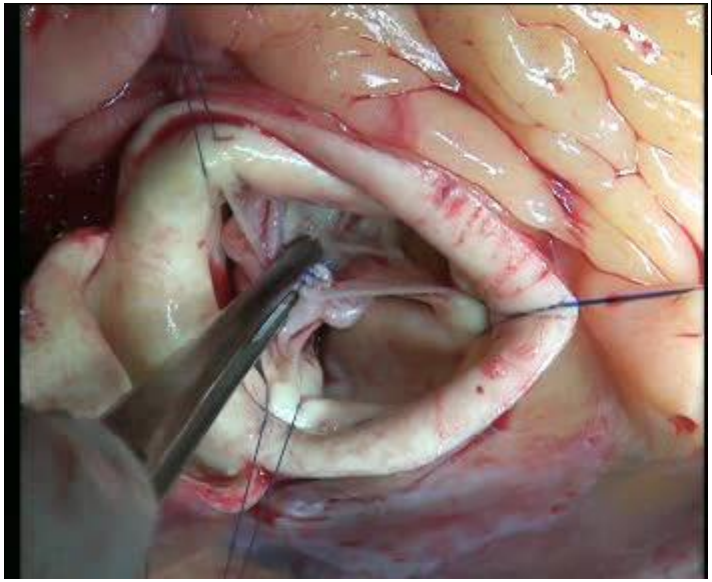


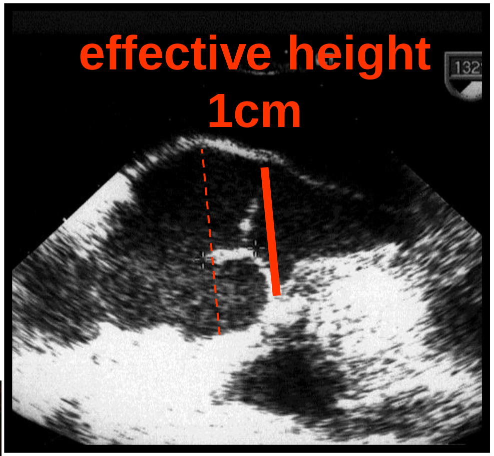
A new approach to the assessment of aortic cusp geometry

Hans-Joachim Schäfers, MD, PhD, Benjamin Bierbach, MD, and Diana Aicher, MD, Homburg/Saar, Germany

Cusp Configuration







Schäfers HJ et al, JTCVS 2006

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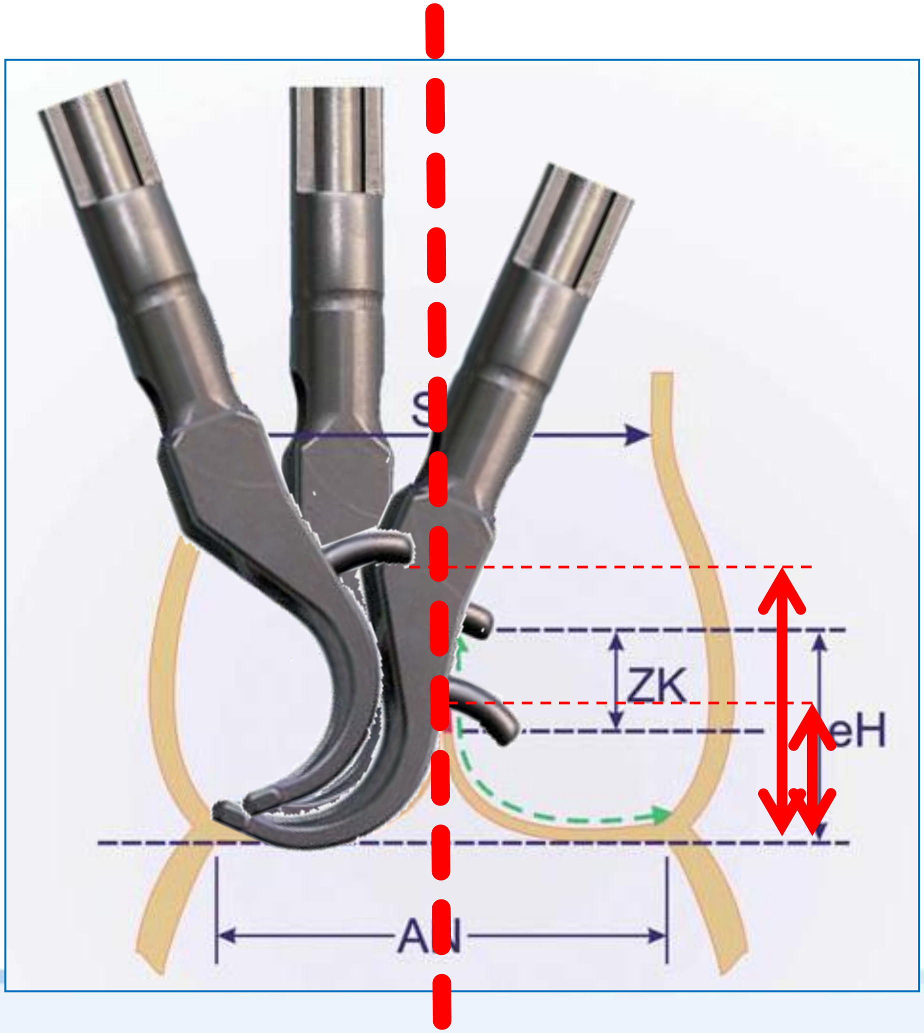
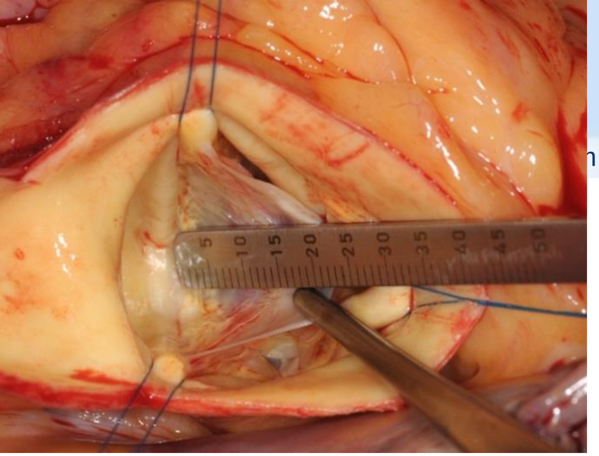
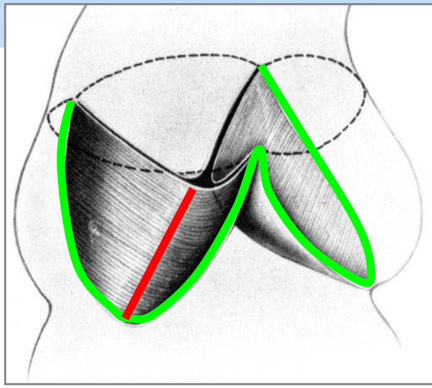
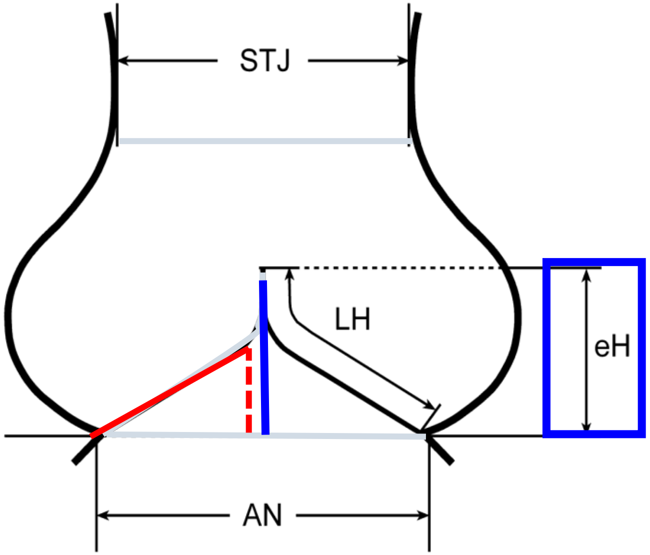
eH Measurement Error





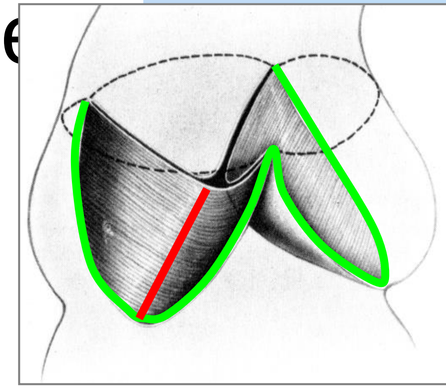
Configurationof cusps





Aortic Valve Repair - Assessme

Solutions



Configuration/coaptation of cusps

Cusp height in aortic valve

Hans-Joachim Schäfers, MD,[a] Wolfram S

Objectives: Successful aortic valve rep
available on the normal dimensions of t

Methods: The cusp height was measure
A tricuspid anatomy was present in 329
height, weight, preoperative degree of ac
analyzed for possible interrelation betw

Results: In the bicuspid valves, the geom
± 2.0). Significant correlations were fou
valves, the height of the noncoronary c
left coronary cusp varied from 12 to 25
to 25 mm (mean, 20.0 ± 2.1). The nonco
cusp (*P* = .000). No difference was foun
between the geometric height and clini
degree of aortic regurgitation.

Conclusions: We found the cusp height
correlates with the clinical variables. T
repair. (J Thorac Cardiovasc Surg 2012;

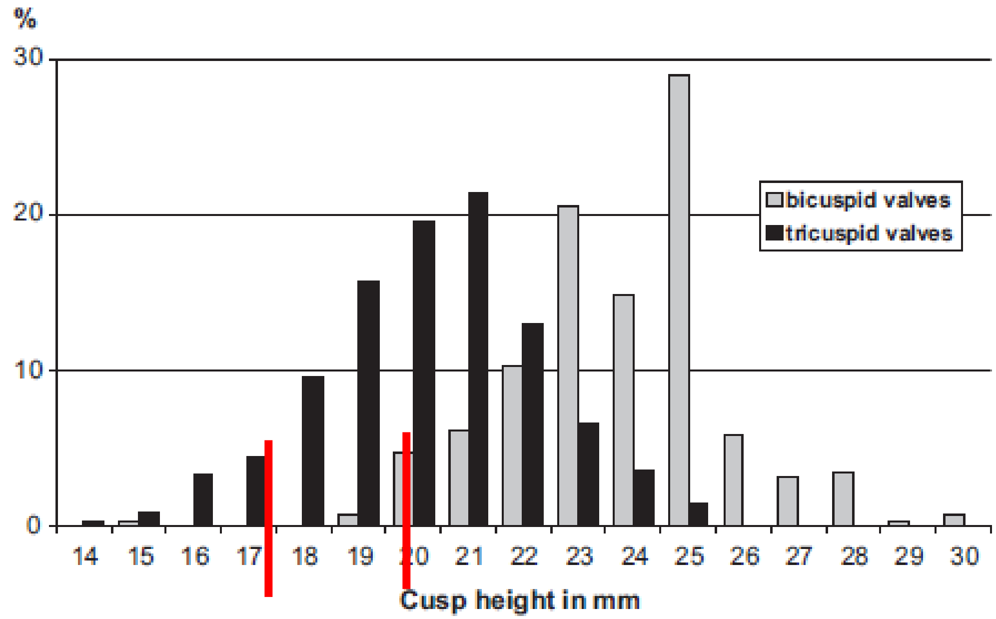
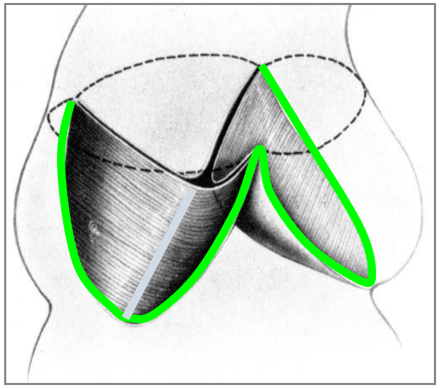


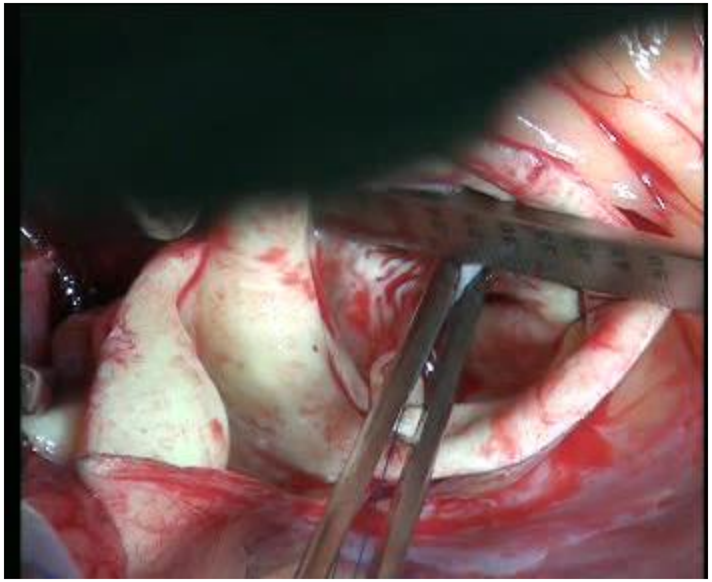
FIGURE 3. Distribution of geometric height in bicuspid (n = 289; nonfused cusps) and tricuspid (n = 332; mean of all 3 cusps) aortic valves.

Aortic Valve Repair - Assessment

Configuration/coaptation of cusps



TAV: 17-22 mm
BAV: 20-25 mm



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Root Correction

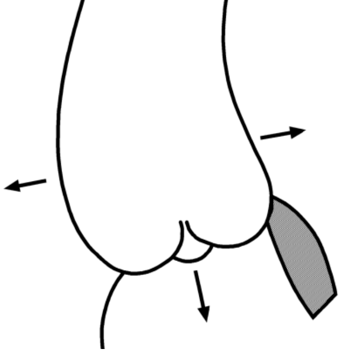
If

Sinus > 40 -45 mm

Root remodeling
(Valve reimplantation)

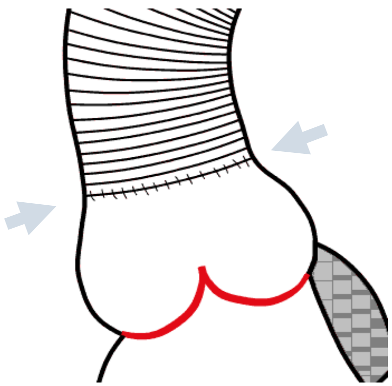
Sinus < 40-45

STJ remodeling



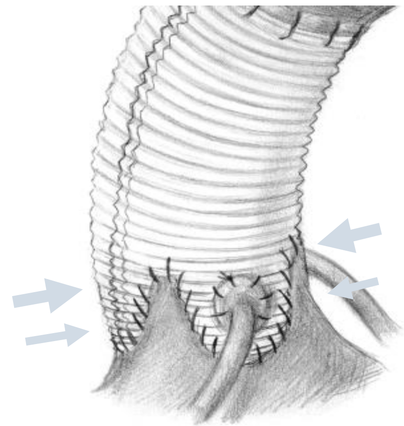
Root Repair – Technical Options

ST Junction
Remodelling



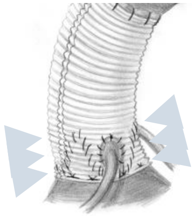
(Frater 1986)
(Sinus < 40-45 mm)

Root
Remodeling



(Yacoub 1993)
(Sinus > 45 mm),

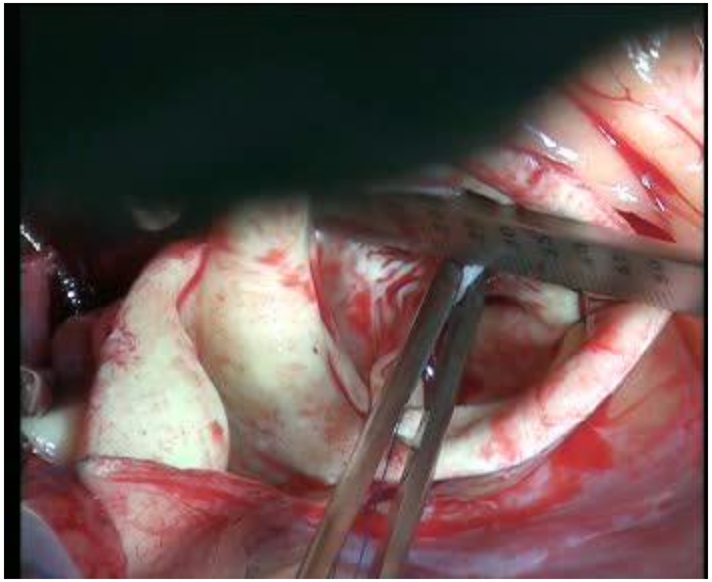
Reimplantation
of Aortic Valve



(David 1992)
(AVJ ≥ 30 mm)

Valve Sparing: Our Routine

1. Measure gH and proceed with VPS if gH ≥ 18 mm



2. (Root remodeling) Take graft according to patient size

BSA	< 1.8 m²	24 mm
	1.8 to 2.2 m²	26 mm
	>2.2 m²	28 mm (?)

if gH ≤ 20 mm consider graft 1 size less

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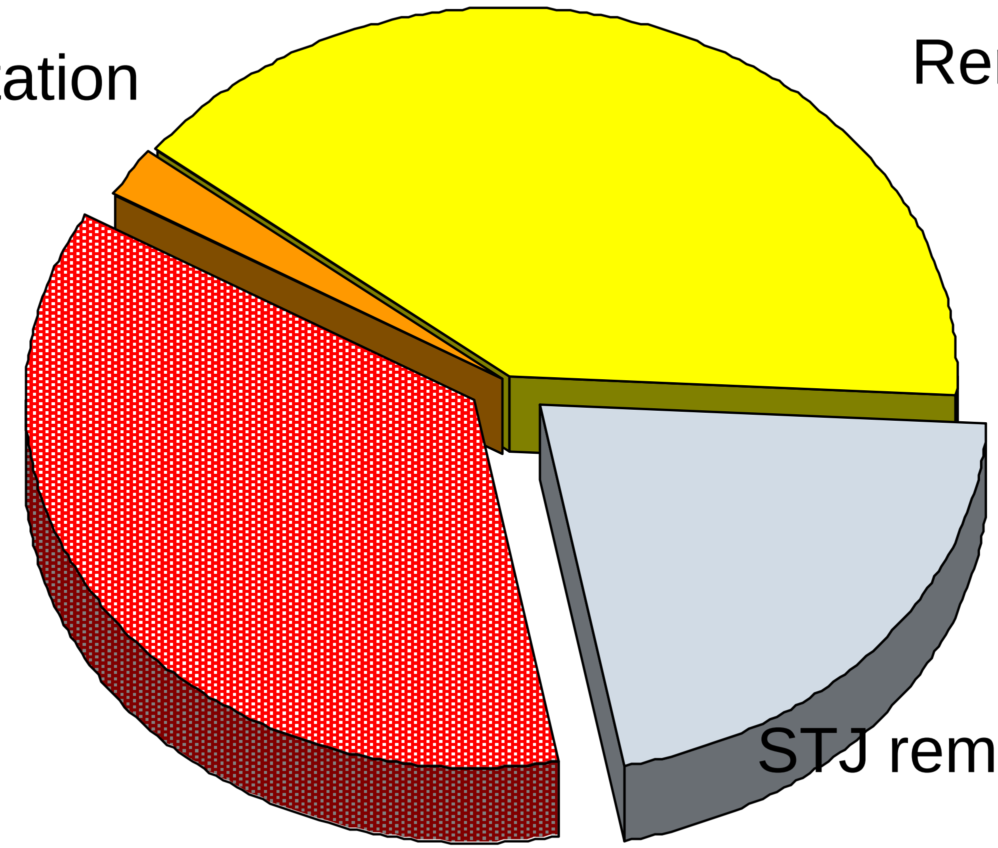
AORTIC VALVE REPAIR

n=1832



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04/10

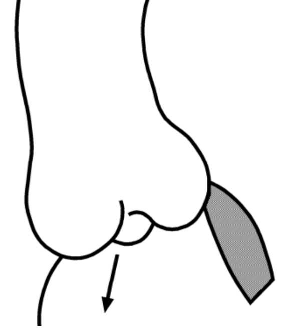
Cusp Correction

If

prolapse (eH ≤ 8 mm)
structural defect
anatomical variant

Plication of free margin / triangular resection
Patch correction
Conversion of anatomy (BAV, TAV constant)

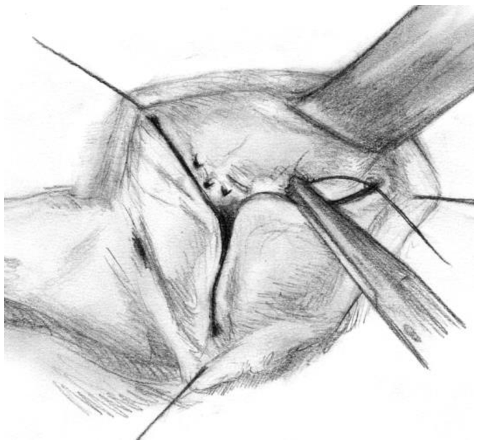
UAV ► BAV
QAV ► TAV



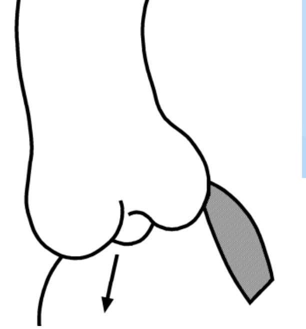
Reconstructive Techniques

Cusp Pathology

Prolapse



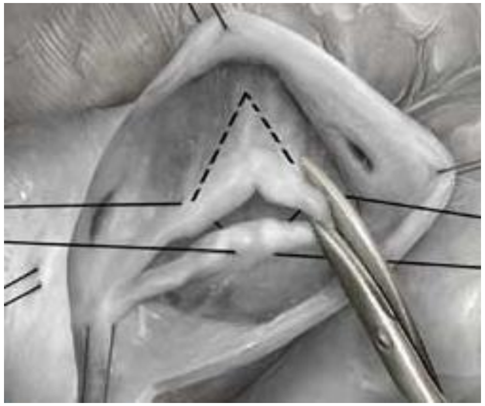
Plication of
Cusp Margin

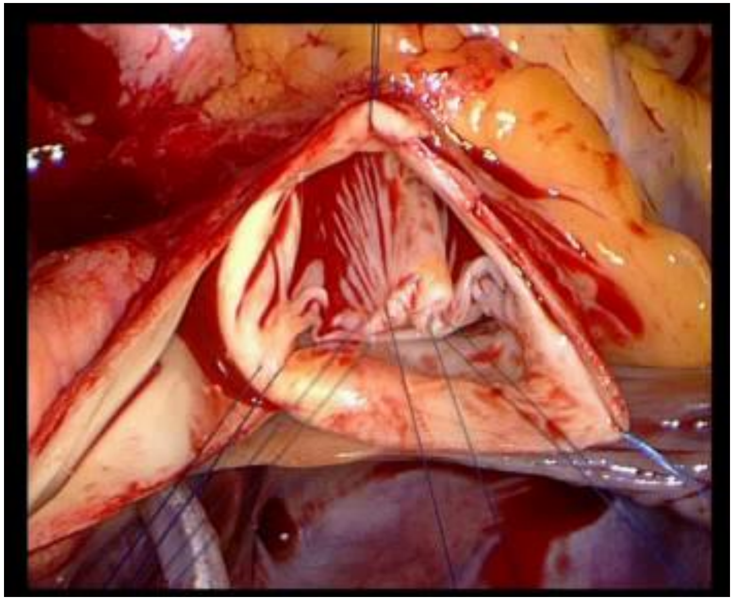


Reconstructive Techniques

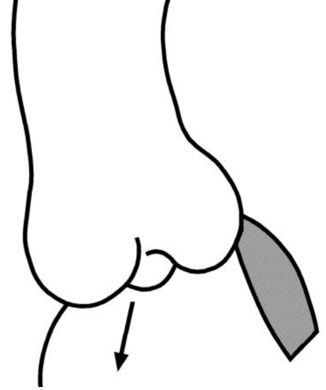
Cusp Pathology

Fibrosis,
Calcium,
Redundancy





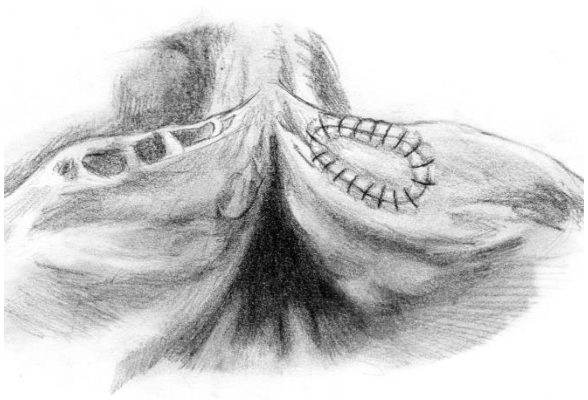
Triangular
Resection



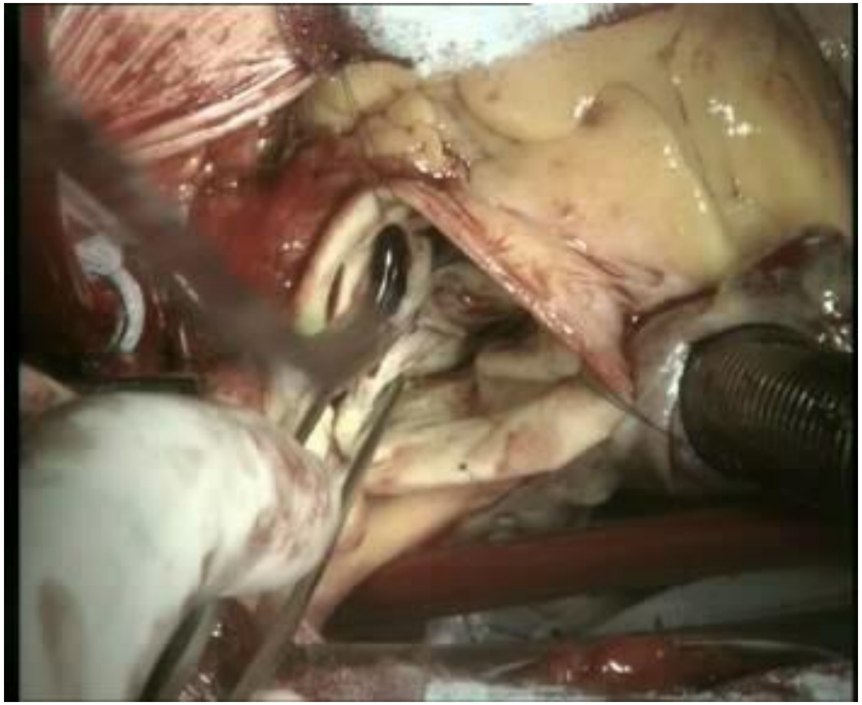
Reconstructive Techniques

Cusp Pathology

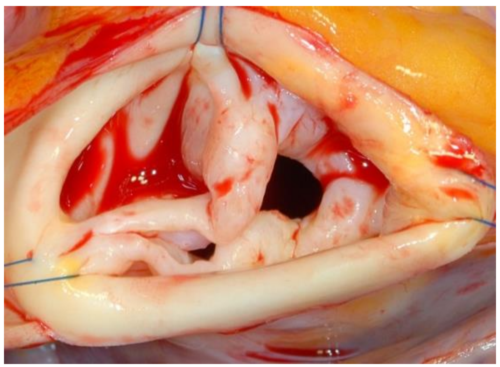
Fenestration

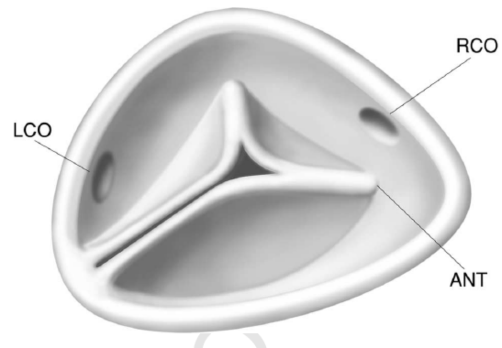


Stabilisation of
cusp (pericardium)



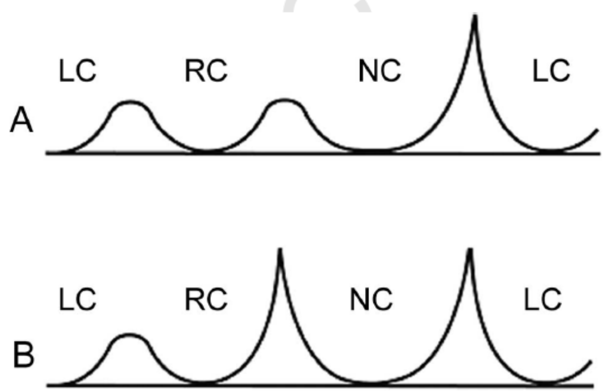
Bicuspidization of the Unicuspid Aortic Valve





unicuspid

bicuspid



Anderson RA, JHVD 2001

Aortic Valve Anatomy

Morphology	Incidence	Mean Age of Failure
Unicuspid	< 1%	20s
Bicuspid	2%	60s
Tricuspid	97 %(?)	?
Quadricuspid	< 1 %	40s

Roberts WC, Circulation

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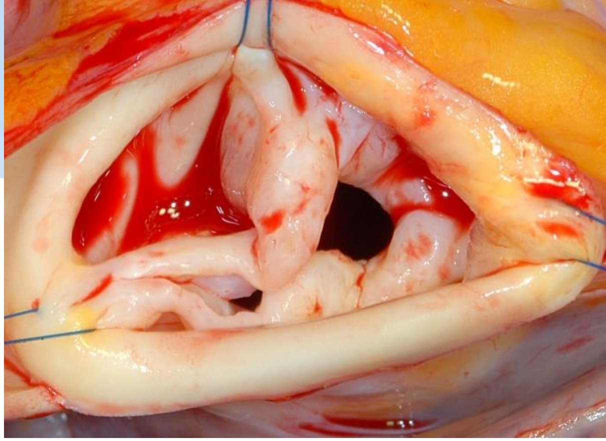
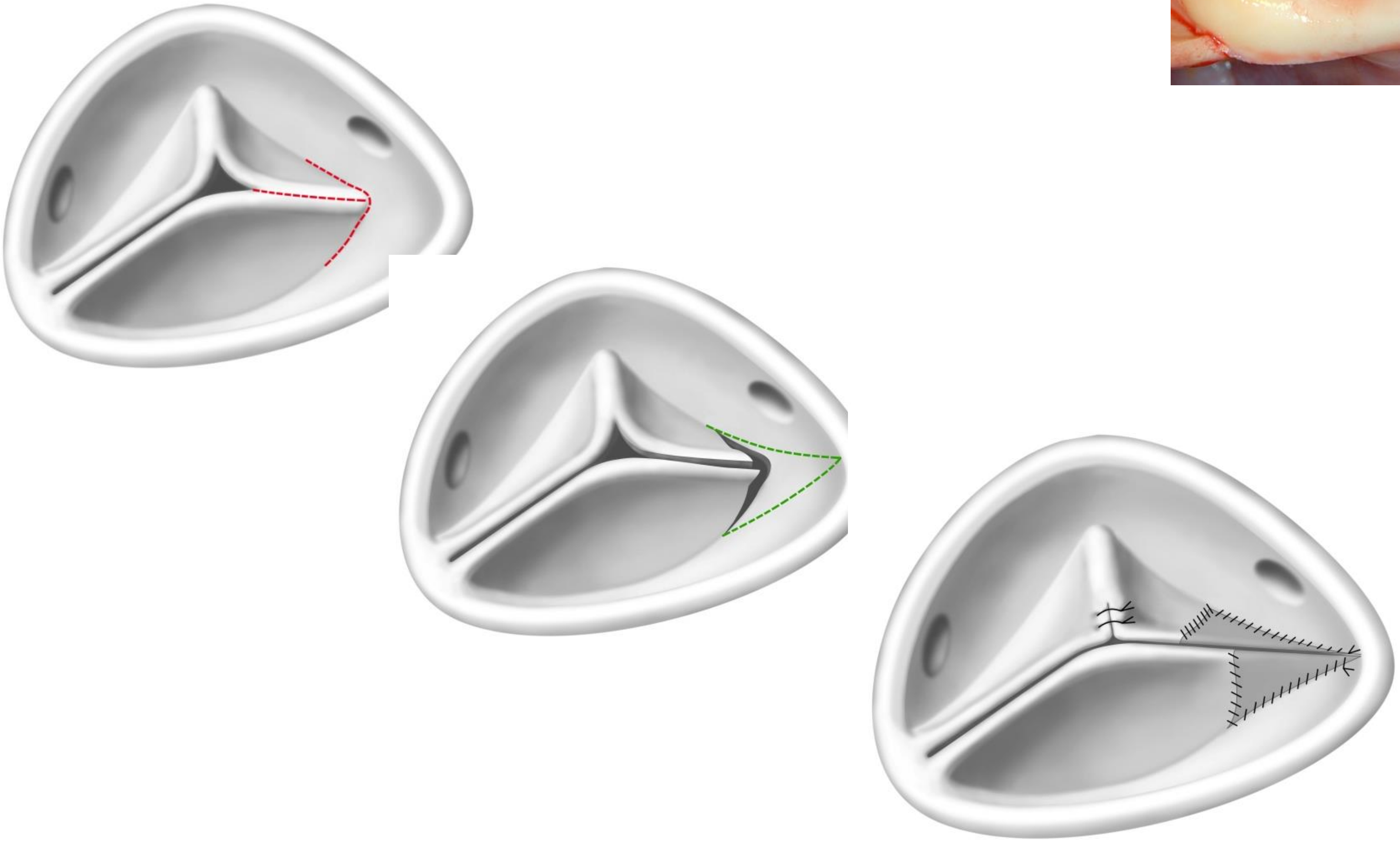
Bicuspidization of the Unicuspid Aortic Valve





Schäfers HJ, ATS 2008

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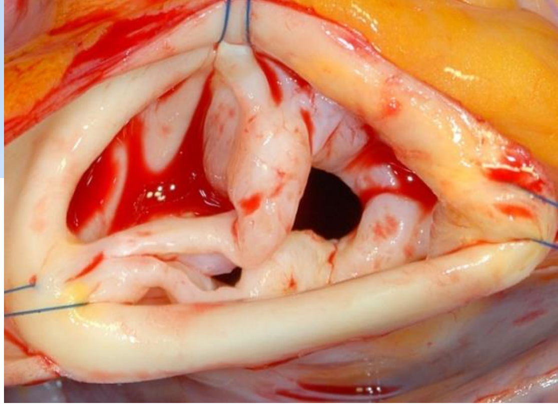
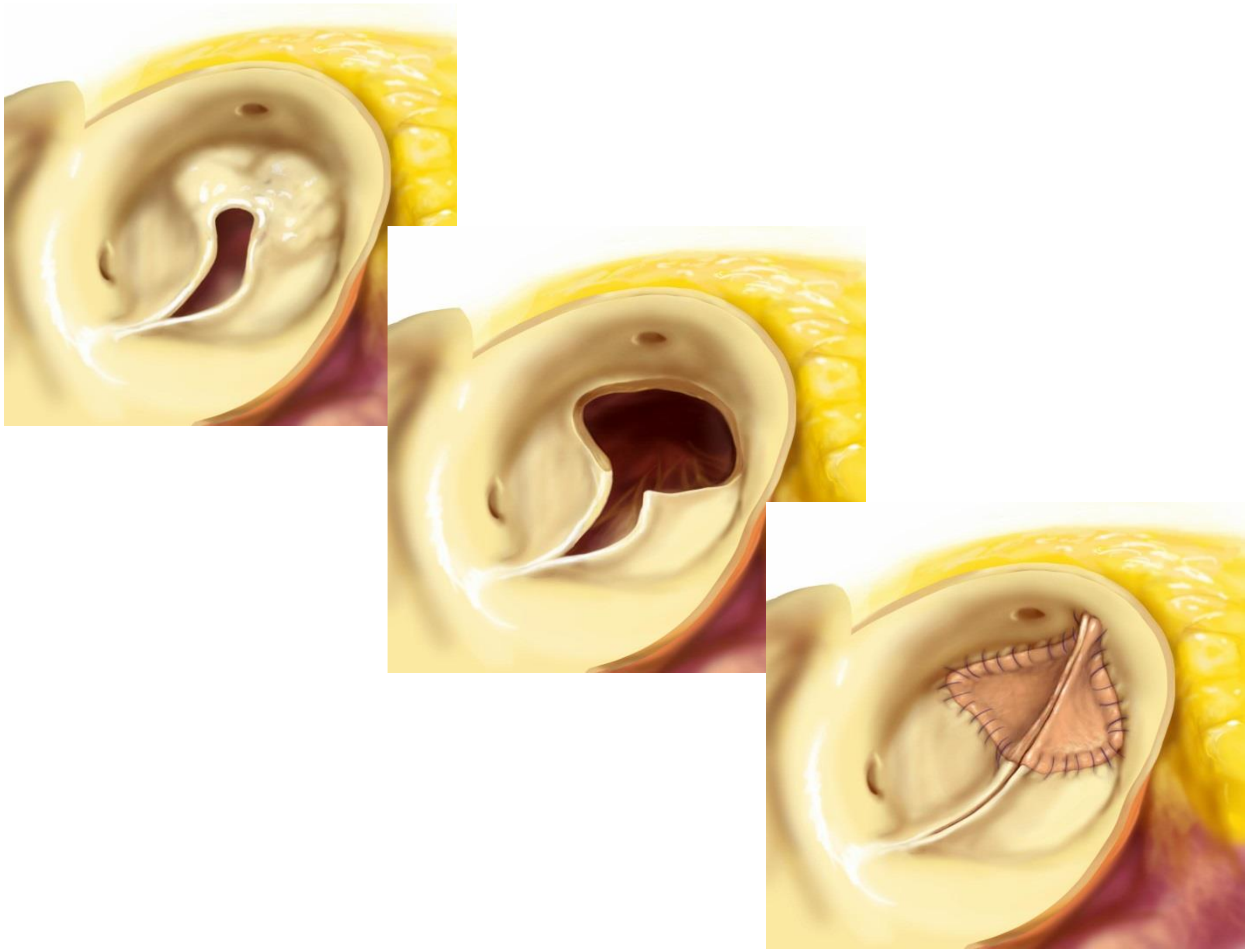
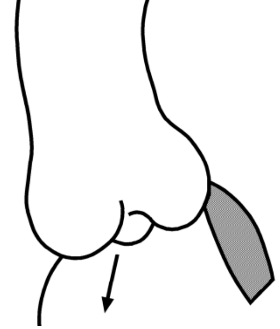
Bicuspidization of the Unicuspid Aortic Valve II



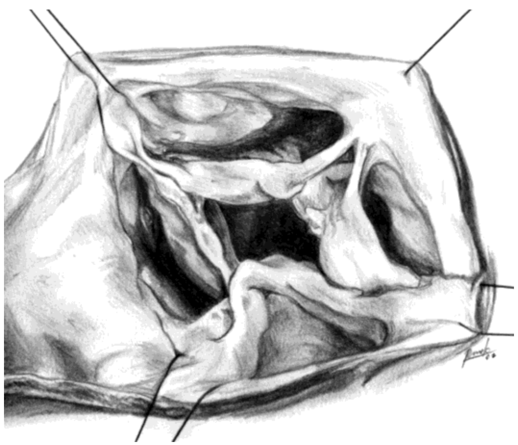




Reconstructive Techniques

Cusp Pathology

Anomaly



Conversion of configuration

Schmidt et al., Ann Thorac Surg 2007

Annuloplasty

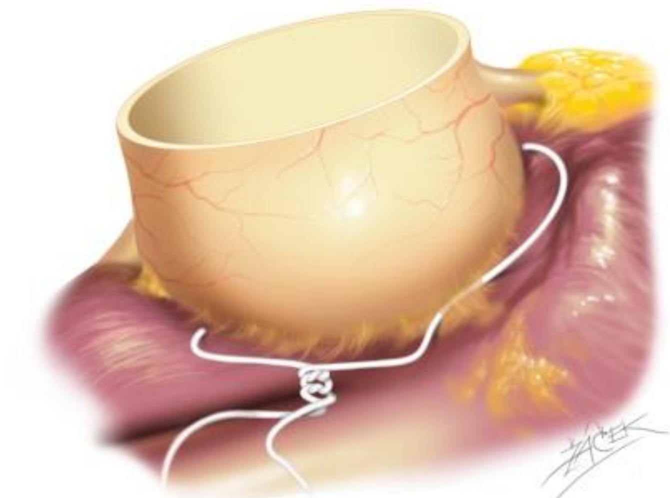
If

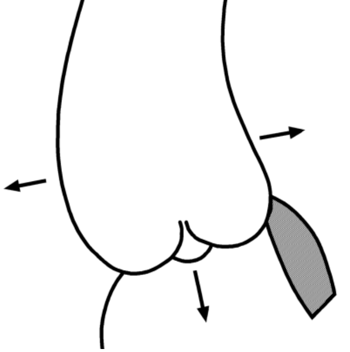
Basal diameter > 26-27 mm

Annular reduction

► 25 mm for BSA > 2 m^2
► 23 mm for BSA < 2 m^2

Reduce by 2 mm for
gH < 19 (TAV) / 22 (BAV) mm



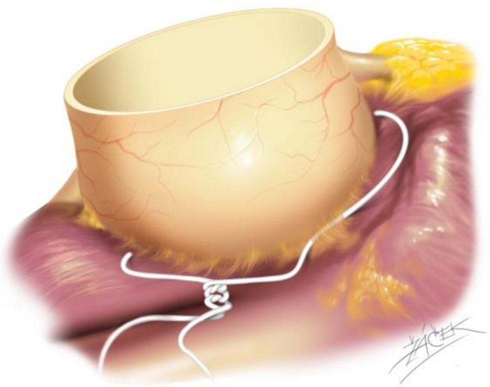


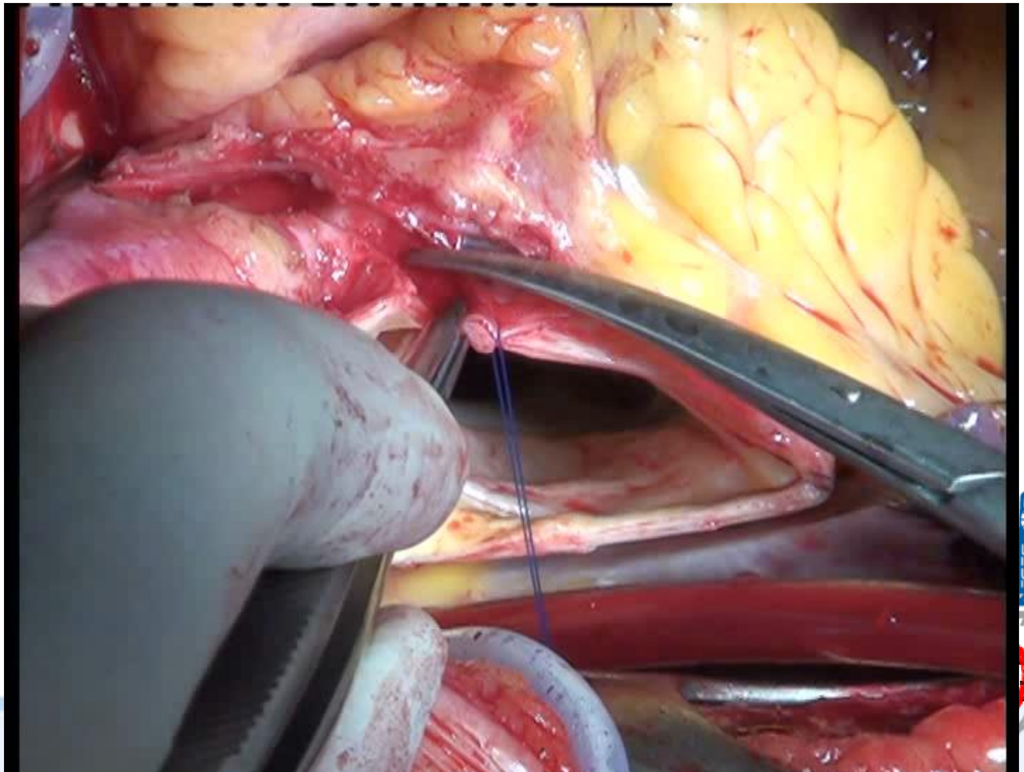
Repair – Technical Options

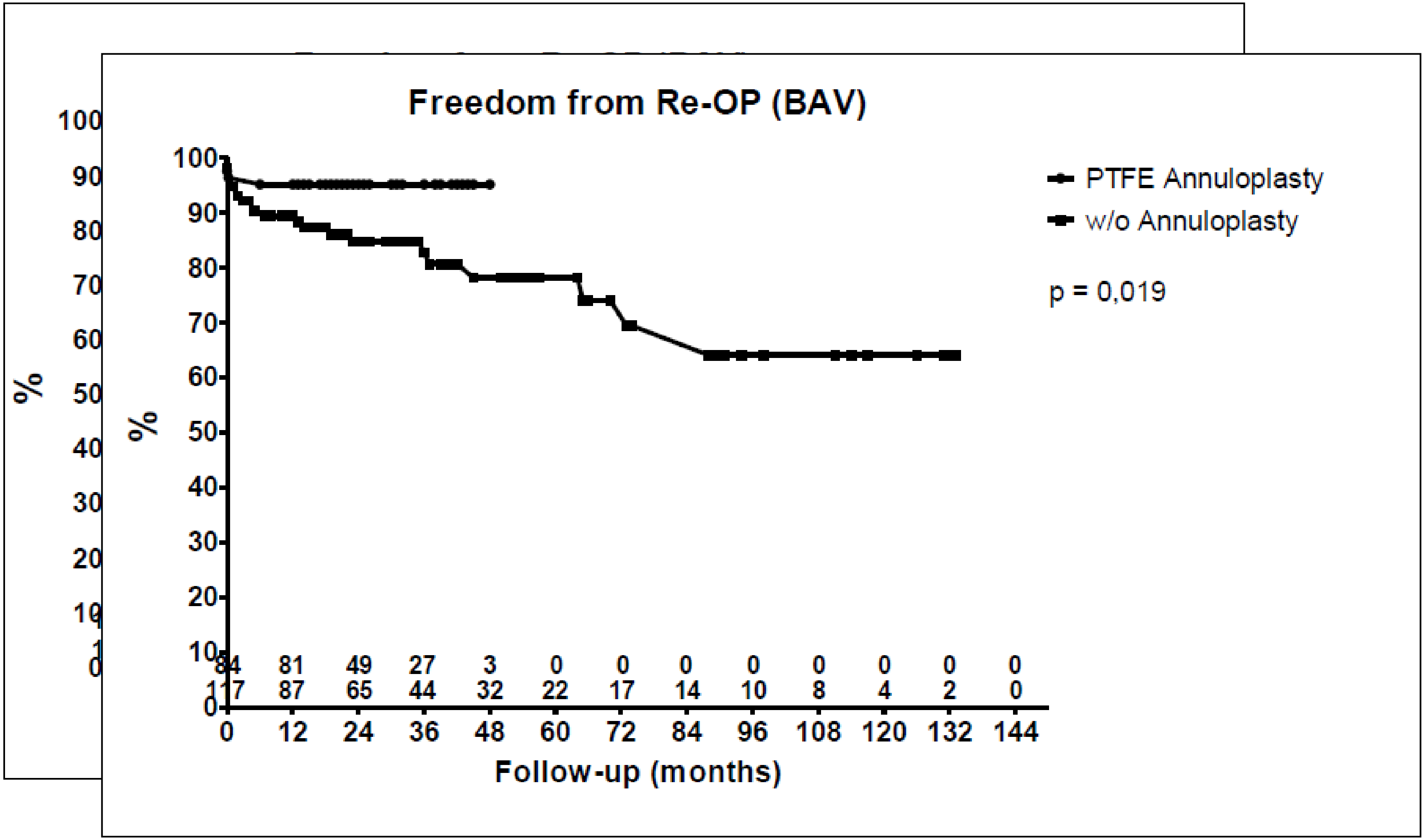
Aortoventricular Stabilisation
(AVJ > 27mm)

Subcommissural Plication

(Cabrol 196






Freedom from Re-OP (BAV)
PTFE Annuloplasty
w/o Annuloplasty
p = 0,019
%
100
90
80
70
60
50
40
30
20
10
0
84 81 49 27 3 0 0 0 0 0 0 0 0
117 87 65 44 32 22 17 14 10 8 4 2 0
0 12 24 36 48 60 72 84 96 108 120 132 144
Follow-up (months)

Standardized Aortic Valve Repair

1. No relevant calcification,
   geometric cusp height > 17-20 mm

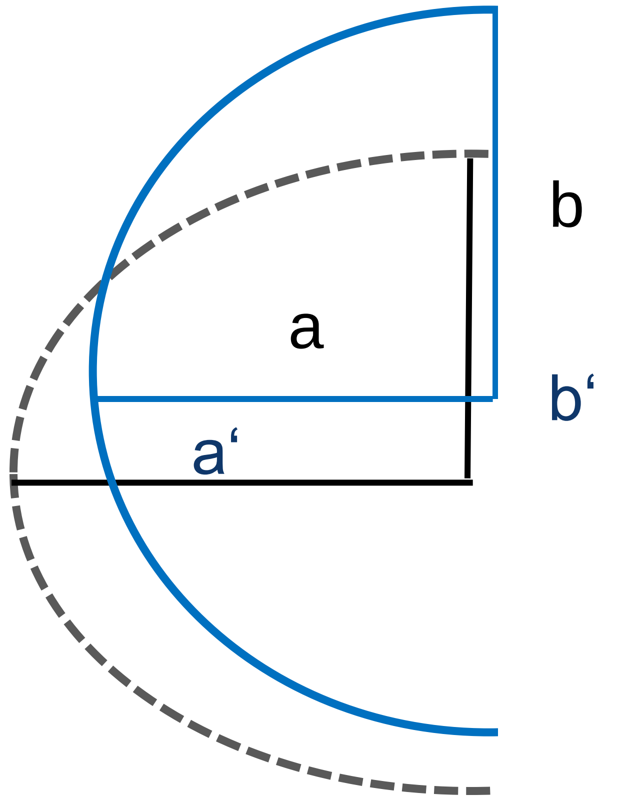
Decision for valve preservation

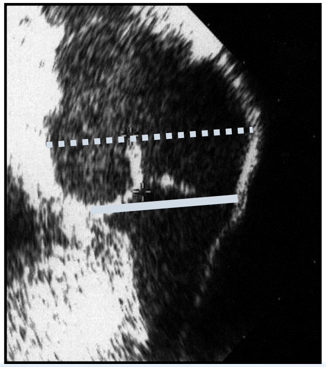
2. Sinus diameter > 40 -45 mm
   (and /or BAV < 150° ?)

Root replacement

THG

Reduction of STJ and Cusp Prolapse





$$C_E = \pi \times [3/2\times(a+b) - \sqrt{a\times b}]$$

$b \approx r_{aorta}$

$a \approx r_{cusp}$

$\Rightarrow$ $r_{cusp} \approx 1 / r_{aorta}$

Standardized Aortic Valve Repair

3. If root + cusp necessary,

Root repair first (interaction between intercommissural distance and cusp configuration)

4. Annular stabilization (AI, durability)

5. Correction of cusp prolapse (eH)

Conclusions

- Systematic analysis + correction of pathologic components
- Many strategies defined
- Normalize cusp configuration (effective height)!
- Specific valve configurations require tailored approach

Aortic Valve Reconstruction